by the energy in the pulse signal 1044, or in an alternative embodiment, the pulse system 1000 can also include an integrated power supply to drive the pulse former.

Figure 12 is a schematic view illustrating an embodiment of pulse system 1200 for use in an embodiment of the stimulation apparatus 600, and an external controller 1210 for controlling the pulse system 1200 remotely from the patient using RF energy. In this embodiment, the external controller 1210 includes a power supply 1220, a controller 1222 coupled to the power supply 1220, and a pulse generator 1230 coupled to the controller 1222. The external controller 1210 can also include a modulator 1232 coupled to the pulse generator 1230 and an RF generator 1234 coupled to the modulator 1232. In operation, the external controller 1210 broadcasts pulses of RF energy via an antenna 1242.

The pulse system 1200 can be housed within the stimulation apparatus 600 (not shown). In one embodiment, the pulse system 1200 includes an antenna 1260 and a pulse delivery system 1270. The antenna 1260 incorporates a diode (not shown) that rectifies the broadcast RF energy from the antenna 1242. The pulse delivery system 1270 can include a filter 1272 and a pulse former 1274 that forms electrical pulses which correspond to the RF energy broadcast from the antenna 1242. The pulse system 1200 is accordingly powered by the RF energy in the pulse signal from the external controller 1210 such that the pulse system 1200 does not need a separate power supply carried by the stimulation apparatus 600.

Figure 13 is a cross-sectional view of a pulse system 1300 for use in another embodiment of the implantable stimulation apparatus 600, together with an external controller 1310 for remotely controlling the pulse system 1300 externally from the patient using magnetic energy. In this embodiment, the external controller 1310 includes a power supply 1320, a controller 1322 coupled to the power supply 1320, and a user interface 1324 coupled to the controller 1322. The external controller 1310 can also include a pulse generator 1330 coupled to the controller 1332, a pulse transmitter 1340 coupled to the pulse generator 1330, and a magnetic coupler 1350 coupled to the pulse transmitter 1340. The magnetic coupler 1350 can include a ferrite core 1352 and a coil 1354 wrapped around a portion of the ferrite core 1352. The coil

1354 can also be electrically connected to the pulse transmitter 1340 so that electrical pulses applied to the coil 1354 generate changes in a corresponding magnetic field. The magnetic coupler 1350 can also include a flexible cap 1356 to position the magnetic coupler 1350 over the implanted stimulation apparatus 600.

The pulse system 1300 can include a ferrite core 1360 and a coil 1362 wrapped around a portion of the ferrite core 1360. The pulse system 1310 can also include a pulse delivery system 1370 including a rectifier and a pulse former. In operation, the ferrite core 1360 and the coil 1362 convert the changes in the magnetic field generated by the magnetic coupler 1350 into electrical pulses that are sent to the pulse delivery system 1370. The electrodes 660 are coupled to the pulse delivery system 1370 so that electrical pulses corresponding to the electrical pulses generated by the pulse generator 1330 in the external controller 1310 are delivered to the stimulation site on the patient.

3. Electrode Configurations

Figures 14-24 illustrate electrodes in accordance with various embodiments of the invention that can be used with the stimulation apparatus disclosed herein. Figures 14-22 illustrate embodiments of electrodes configured to apply an electrical current to a stimulation site at least proximate to the pial surface of the cortex, and Figures 23 and 24 illustrate embodiments of electrodes configured to apply an electrical current within the cortex or below the cortex. It will be appreciated that other configurations of electrodes can also be used with other implantable stimulation apparatus.

Figure 14 is a bottom plan view and Figure 15 is a cross-sectional view of a stimulation apparatus 1400 in accordance with an embodiment of the invention. In this embodiment, the stimulation apparatus 1400 includes a first electrode 1410 and a second electrode 1420 concentrically surrounding the first electrode 1410. The first electrode 1410 can be coupled to the positive terminal of a pulse generator 1430, and the second electrode 1420 can be coupled to the negative terminal of the pulse

generator 1430. Referring to Figure 15, the first and second electrodes 1410 and 1420 generate a toroidal electric field 1440.

Figure 16 is a bottom plan view and Figure 17 is a cross-sectional view of a stimulation apparatus 1600 in accordance with another embodiment of the invention. In this embodiment, the stimulation apparatus 1600 includes a first electrode 1610, a second electrode 1620 surrounding the first electrode 1610, and a third electrode 1630 surrounding the second electrode 1620. The first electrode 1610 can be coupled to the negative terminals of a first pulse generator 1640 and a second pulse generator 1642; the second electrode 1620 can be coupled to the positive terminal of the first pulse generator 1640; and the third electrode 1630 can be coupled to the positive terminal of the second pulse generator 1642. In operation, the first electrode 1610 and the third electrode 1630 generate a first toroidal electric field 1650, and the first electrode the 1610 and the second electrode 1620 generate a second toroidal electric field 1660. The second toroidal electric field 1660 can be manipulated to vary the depth that the first toroidal electric field 1650 projects away from the base of the stimulation apparatus 1600.

Figure 18 is a bottom plan view and Figure 19 is a cross-sectional view of a stimulation apparatus 1800 in accordance with yet another embodiment of the invention. In this embodiment, the stimulation apparatus 1800 includes a first electrode 1810 and a second electrode 1820 spaced apart from the first electrode 1810. The first and second electrodes 1810 and 1820 are linear electrodes which are coupled to opposite terminals of a pulse generator 1830. Referring to Figure 19, the first and second electrodes 1810 and 1820 can generate an approximately linear electric field.

Figure 20 is a bottom plan view of a stimulation apparatus 2000 in accordance with still another embodiment of the invention. In this embodiment, the stimulation apparatus 2000 includes a first electrode 2010, a second electrode 2020, a third electrode 2030, and a fourth electrode 2040. The first and second electrodes 2010 and 2020 are coupled to a first pulse generator 2050, and the third and fourth electrodes 2030 and 2040 are coupled to a second pulse generator 2060. More specifically, the first electrode 2010 is coupled to the positive terminal and the second